



PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of

Hojung LEE et al.

Group Art Unit: 1611

Application No.: 10/743,523

Examiner: C. RAE

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Docket No.: 118109

For: COSMETIC COMPOSITION OF FOUNDATION TYPE FOR MAKING UP DARK SKINS

DECLARATION UNDER 37 C.F.R. § 1.132

Commissioner for Patents
P.O. Box 1450
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Sir:

I, Ludovic THEVENET, declare that:

1. I am a citizen of France, residing at 128 Avenue du Général Leclerc 92340 Bourg la reine.
2. I have been awarded a degree in Doctorat of Philosophy level from the University of Lille, and have received a doctorate in Optics, Applied Mathematics & Computer Graphics Applications.
3. I have been employed by L'OREAL since December 2003 and I am presently a Laboratory Manager of the Color & Optical Laboratory at L'OREAL. During my employment at L'OREAL, I have been engaged in research and development regarding Optics & Color.
4. I have a professional relationship with the assignee of the above-identified patent application. In the course of that professional relationship, I received compensation directly

from the assignee for my work relating to all project linked to color for all makeup application. I am being compensated for my work in connection with this Declaration.

5. Given my education and experience, particularly in the area of Optic& makeup, I have reviewed and am familiar with the experiments discussed in this Declaration. Furthermore, I consider myself able to provide the following statements based on my review of experiments conducted in L'OREAL laboratories.

I. Technical Disadvantages of the Prior Art

In this field, there is a long-standing consumer need for cosmetic foundation compositions that achieve seamless, uniform color and appearance in various areas of the face (e.g., the forehead, the under eye area, and the cheekbones), while not making darker skin appear grey or ashen. To accomplish these goals, L'OREAL conducted research on a novel colorimetric approach, taking into account the fact that colorimetric parameters that are specific to dark skin would be relevant for achieving efficient make-up compositions. L. Caisey et al. provide an illustration of skin classification by colorimetric parameters in Table I and Figure 3 of "Skin Color and Makeup Strategies of Women From Different Ethnic Groups," International Journal of Cosmetic Science, Vol. 28, pp. 427-437 (2006) (attached herewith).

II. Evaluation using Colorimetric Parameters

Using measurements from a spectrophotometer, a spectral curve is plotted, which may then be transformed into trichromatic coordinates, representing the corresponding color points in a three dimensional space.

The CIE 1976 colorimetric space enables two modes of color representation: 1) the first mode is based on the rectangular coordinates (L^* , a^* , b^*) and is made following the lightness axis (L^*), the red/green chromatic axis (a^*) and the yellow/blue chromatic axis (b^*); and 2) the second mode is based on the cylindrical coordinates (L^* , C^* , h) and is made following the lightness axis (L^*), the saturation axis (C^*) and the hue angle axis (h°). Thus, dark skin complexions were evaluated using the above two modes of color representation.

The research project was conducted taking into consideration the needs of a specific population, specifically people having dark skin with a mean lightness L^* less than 60, as measured on the forehead, cheekbones and chin in a CIE 1976 colorimetric space.

The inventors of the present application unexpectedly discovered that the following features of the present application resolved the problem found in the prior art (discussed above) for the population of consumers with dark skin: 1) at least one organic coloring agent having a reflectance with a dominant wavelength of yellow or orange coloration in the range from 550 to 675 nm; and 2) reflective particles comprising at least one nacre.

By especially defining lower and upper limits for the parameters characterizing respectively the two systems of color representation, it was possible to develop a cosmetic composition of foundation type that is virtually or even totally free of grey or ashen appearance, unlike conventional cosmetic compositions. Accordingly, the present invention provides make-up with a more natural appearance for consumers with dark skin.

III. Comparative Test Data

The following compositions were prepared. Composition A is an exemplary embodiment of the present invention. Unlike Composition A, Comparative composition B does not contain any organic coloring agent having a reflectance with a dominant wavelength of yellow or orange coloration in the range from 550 to 675 nm.

INCI Name	Composition A (% by weight)	Comparative Composition B (% by weight)
SODIUM CHLORIDE	0.70	0.70
DISTEARDIMONIUM HECTORITE		1.60

CYCLOPENTASILOXANE (and) DISTEARDIMONIUM HECTORITE (and) ALCOHOL DENAT.	12.96	-
ISOSTEARYL NEOPENTANOATE	0.50	0.50
HEXYL LAURATE	0.60	0.60
YELLOW 6 LAKE	2.00	-
YELLOW IRON OXIDES (and) C9-15 FLUOROALCOHOL PHOSPHATE	1.28	4.58
BROWN IRON OXIDES (and) C9-15 FLUOROALCOHOL PHOSPHATE	2.13	1.76
BLACK IRON OXIDES (and) C9- 15 FLUOROALCOHOL PHOSPHATE	0.47	1.93
TITANIUM DIOXIDE (and) C9- 15 FLUOROALCOHOL PHOSPHATE	-	3.73
ULTRAMARINES (and) C9-15 FLUOROALCOHOL PHOSPHATE	1.28	-
PHENOXYETHANOL	0.50	-
DIAZOLIDINYL UREA	-	0.30
PROPYLPARABEN	0.15	0.25
METHYLPARABEN	0.25	0.25
MICA (and) TITANIUM DIOXIDE	-	2.00
MICA (and) BROWN IRON OXIDES	2.00	-
METHYL METHACRYLATE CROSSPOLYMER	2.00	4.00
POLYMETHYL METHACRYLATE	2.00	-

CYCLOPENTASILOXANE	5.17	11.90
CYCLOHEXASILOXANE	8.00	7.00
DIMETHICONE	2.00	2.50
CETYL PEG/PPG-10/1 DIMETHICONE	0.80	0.80
PEG-10 DIMETHICONE	4.48	5.00
BUTYLENE GLYCOL	10.00	3.00
WATER	25.07	24.80
GLYCERIN	-	7.00
ISODODECANE	12.98	13.00
ISOEICOSANE	2.00	2.00
POLYGLYCERYL-4 ISOSTEARATE	0.60	0.60
TOCOPHEROL	0.08	0.10
PANTHENOL	-	0.10

Colorimetric parameters C^* and h of these composition were measured as indicated in the present specification. The saturation and hue angle of the compositions are as follows:

	Composition A	Comparative Composition B
Saturation C^*	23.06	20.55
Hue angle h	42.08	53.75

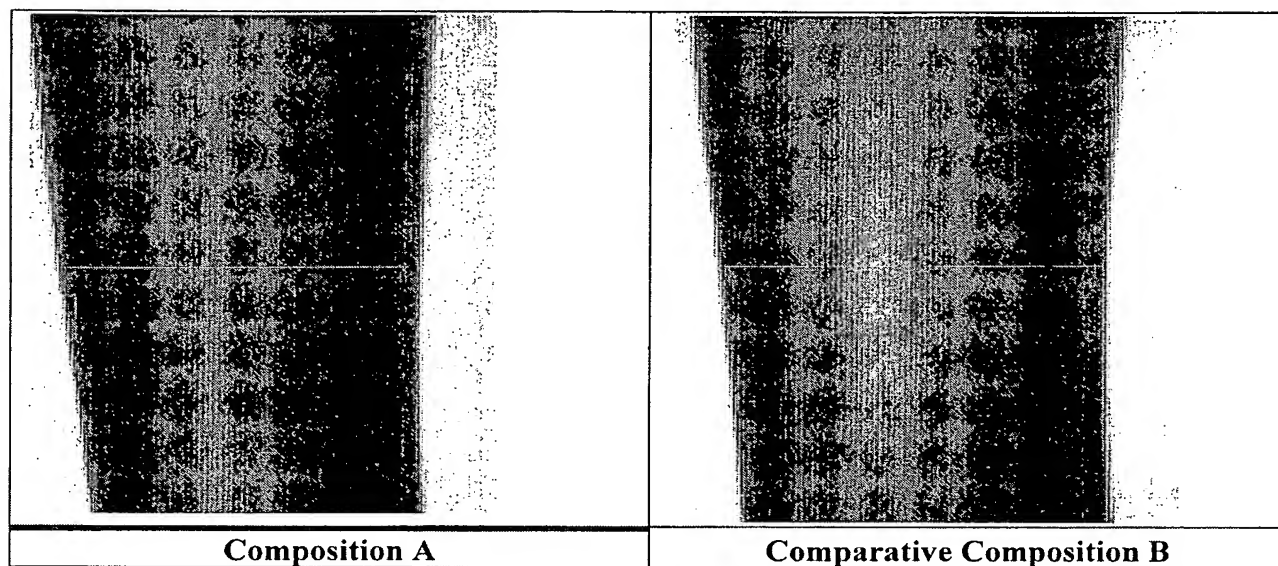
Composition A (an exemplary embodiment of the present invention) and Comparative Composition B were applied to the forearm of a test subject with dark skin. The colorimetric parameters of the test subject's skin were:

$$L^*_{\text{skin}} = 37.71 ; a^*_{\text{skin}} = 9.46 \text{ and } b^*_{\text{skin}} = 13.13$$

The following colorimetric parameters of the test subject's skin were measured, after application of Composition A and Composition B.

	Composition A	Comparative Composition B
Saturation C*	21.32	15.10
Lightness L*	36.19	40.96

The photographs below show the area of the test subject's skin where Composition A and Composition B were applied:



The above photographs clearly demonstrate the dramatic make-up difference associated with the features of the present invention. Composition A contains both an organic coloring agent having a reflectance having a dominant wavelength of yellow or orange coloration in a range from 550 to 675 nm (e.g. Yellow 6 Lake) and a nacre (e.g., mica coated with an iron oxide), while Composition B contains no organic coloring agent.

The photograph above clearly shows the area where Composition A was applied does not have the grey or ashen appearance of Composition B. Rather, the photograph shows the seamless natural appearance of the make-up on the test subject's skin, demonstrating the surprising and unexpected advantages derived from the claimed organic coloring agent and the claimed nacre in the claimed composition and claimed method.

These improvements are commercially significant. Clearly, make up for consumers with dark skin that does not have a grey or ashen appearance and imparts a uniform color in various

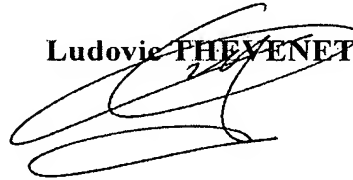
areas of the face is commercially superior to compositions with the inferior properties shown in the comparative example.

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further, that these statements were made with the knowledge that wilful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United-States Code, and that such wilful false statements may jeopardize the validity of the application or any patent issuing thereon.

Date: April 21st, 2009

By: Ludovic Thevenet

Ludovic THEVENET



Skin color and makeup strategies of women from different ethnic groups

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Synopsis

The development of a world-wide makeup foundation range requires a thorough understanding of skin color features of women around the world. To understand the cosmetic needs of women from different ethnic groups, we measured skin color in five different groups (French and American Caucasian, Japanese, African-American, and Hispanic-American) and compared the data obtained with women's self-perception of skin color, before or after applying their usual foundation product. Skin color was measured using a spectroradiometer and a spheric lighting device with CCD camera ensuring a highly reliable imaging and data acquisition. The diversity of skin types involved in the study lead to define a large, continuous color space where color spectra from various ethnic groups overlap. Three types of complexion – dark, medium, or light – were distinguished in each group. Only Japanese women did not identify with this lightness scale and considered it makes more sense to classify their skin according to a pink-ocher-beige color scale. The approach however revealed the great variety of skin colors within each ethnic group and the extent of unevenness. A fairly good agreement appeared between women's self-perception and data from color measurements but in Hispanic-American group. Data recorded, after foundation was applied, showed overall consistency with makeup strategy as described by volunteers except

for the latter group whose approach looked more uncertain and variable. The findings of the study demonstrate the advantage of combining qualitative and quantitative approach for assessing the cosmetic needs and expectations of women from different ethnic origin and cultural background.

Résumé

La formulation d'une gamme internationale de fonds de teint passe par une connaissance approfondie de la couleur des carnations des femmes dans le monde. Des mesures instrumentales précises ont été réalisées sur 5 groupes ethniques (caucasiennes françaises et américaines, japonaises, afro-américaines et hispano-américaines) pour caractériser la couleur de peau. Ces mesures ont été confrontées à la perception que les femmes ont de leur teint avant et après maquillage avec leur produit habituel, afin de développer des gammes de fonds de teint les plus appropriés. Les mesures de couleur et d'hétérogénéité pigmentaire de la peau ont été effectuées avec un spectro-radiomètre et une sphère combinant un éclairage stable et diffus et un système d'acquisition parfaitement reproductible. Les mesures sur peau nue révèlent un espace des couleurs continu avec interpénétration des groupes ethniques. Chaque groupe a été étudié en distinguant 3 sous-groupes de carnation: claire/moyenne/foncée. Seules les japonaises ne se reconnaissent pas dans cette échelle de clarté et lui préférèrent une échelle de couleur rose/ocre/beige. Ce mode de classification a néanmoins mis en évidence l'hétérogénéité des couleurs de peau au sein de chaque groupe ethnique et le degré d'inhomogénéité de la carnation. On observe une

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bonne concordance entre les mesures de couleur et l'auto-perception des femmes sauf dans le groupe hispano-américain. Les mesures effectuées après maquillage confirment la bonne cohérence globale des stratégies maquillage décrites par les sujets sauf dans ce groupe au comportement plus aléatoire et plus contrasté. Les résultats de l'étude démontrent la pertinence d'une double approche qualitative et instrumentale pour appréhender les besoins et les attentes cosmétiques de femmes ayant des origines ethniques et des influences culturelles différentes.

Introduction

It is clear that skin characteristics vary greatly according to ethnic origin, and that a range of factors such as the geographical or cultural environment may influence skin properties [1]. A better knowledge of these issues and an improved, systematic approach to evaluate them are prime factors in the development of skin care and cosmetic products that address distinct needs of different consumer groups. The evaluation of multicultural information about skin complexion and skin tones will guide laboratories in formulating skin products and facial cosmetics for different ethnic groups. A better understanding of the different needs of women in various communities is important in order to develop cosmetic product ranges that are appropriate to consumer target groups.

Several studies have addressed the issue of differences in hair and skin condition between different ethnic groups [1, 2]. They focused on the structure of pigmented skins and their biophysical and biomechanical properties showing that the stratum corneum in black skin consisted of more layers than in white skin and spontaneously removed 2.5 times as much as in white and Asian skin. This was attributed to the level of ceramides which was at the highest in Asian skin followed by white skin, and the lowest in black skin. Melanosome size, distribution and groupings also varied among the different ethnic groups and were determining factors in lightness or darkness of the skin. In hair, more pigments were found in African type and electron microscopy showed larger melanin granules compared with hair from light-skinned and Asian women. A number of papers have detailed ethnic differences in hair characteristics and emphasized the needs for ethnic-specific hair products [3]. However, few research studies

have focused specifically on skin color perception [4] and measurement [5] and the way skin complexion tone may influence cosmetic needs and makeup strategies of women from different groups in various parts of the world [6, 7].

The present study was designed to explore these issues by combining a consumer-based approach with skin color measurements under standard conditions, in order to assess skin complexion tone in women from different ethnic groups and living in different geographical locations. The aim of the study was to investigate how self-description of facial skin complexion in women was influenced by skin color, ethnic origin, and living place. In parallel, quantitative data on facial skin was recorded *in vivo* in order to obtain an objective assessment of skin color before and after the application of foundation. This large-scale study involving 507 women from distinct ethnic backgrounds provides important insights into how skin color and self-perception of skin complexion influence the cosmetic expectations of different communities of women around the world.

Methods

Volunteers

The study involved 507 healthy women from five distinct ethnic groups using foundation on a daily basis and living in different geographical locations: 112 French Caucasian women were enrolled in Paris, 107 American Caucasian women in New York, 118 Japanese-Asians in Tokyo, 75 African-Americans, and 95 Hispanic-Americans in New York. The volunteers were from 25 to 65 years old including 170 women in the age range 25–35, 174 women in the range 36–45 and 163 women in the range 46–65, respectively. Each group had an equal number of women from each of the three skin complexion sub-groups (dark, medium, and light). The skin complexion sub-group was defined based on women's self-perception.

Exclusion criteria were any disease that may impair or change color of facial skin condition. The hormonal status as well as the use of contraceptives was not considered. In this study, the use of other cosmetics such as facial cleansers, moisturizers, or any skin care products before applying foundation was not taken into account. The volunteers were instructed not to make any change in their cosmetic routine.

Fourteen women from each ethnic group were selected to participate in semi-directive in-depth interviews to establish their self-perception about skin complexion.

They were chosen according to their normal foundation usage, i.e. exclusive liquid foundation users only. Ethnic sample groups were balanced for age distribution. Groups were composed of an equal number of women from each of the three age sub-groups (25–35, 36–45, and 46–65 years) and an equal number of women from each of the three skin complexion sub-groups (dark, medium, and light) defined according to women's self-perception. Half of each sample group used mass market liquid foundation brands, whereas the other half used prestige brands. The subjects themselves declared their particular ethnic identity. Those declaring mixed ethnic origin were not included in the study.

Quantitative analysis: measurement of skin color

The ChromaSphere device was used to evaluate skin color evenness, and a spectro-radiometer for colorimetry.

The ChromaSphere is a proprietary device developed for measuring characteristics of whole face or facial areas [8]. The ChromaSphere was used to obtain images and data on full-face, right cheek, or chin color features. The ChromaSphere device includes a lighting system combined with an

imaging system. The light (Xenon lamp specified D65) is stable and diffuse and faithfully mimics natural daylight from the sun. The image recording system was perfectly reproducible. We used both a tri-CCD camera (Hitachi) and a spectro-radiometer for data acquisition. The CCD camera was calibrated to ensure reliable imaging with faithful color reproducibility [9]. The spectro-radiometer provided the spectrum of the chin, cheek and forehead, and thus their colorimetric parameters.

Quantitative data from measurements of skin complexion tone included lightness (L^*), chroma (C^*) and hue (h), and were expressed in the CIE 1976 standard colorimetric space: L^* , a^* , b^* , C^* , h . ChromaSphere images and color measurements were taken at two periods: at T_0 on 'bare' skin (subjects carefully cleansed their face to remove any makeup prior to facial imaging) and at T_1 after applying makeup.

Skin unevenness was assessed both on cheek area and by comparing two skin areas of the face, i.e. cheek versus chin. The cheek unevenness was measured within a representative square area (300×300 pixels) in the cheek picture (768×576 pixels) (Fig. 1) and was expressed by L^* evenness which stands for the standard deviation of lightness in the tested area. Skin unevenness between cheek and chin, ΔL^* , is the difference between the L^* mean values recorded on two matched areas of cheek and chin.

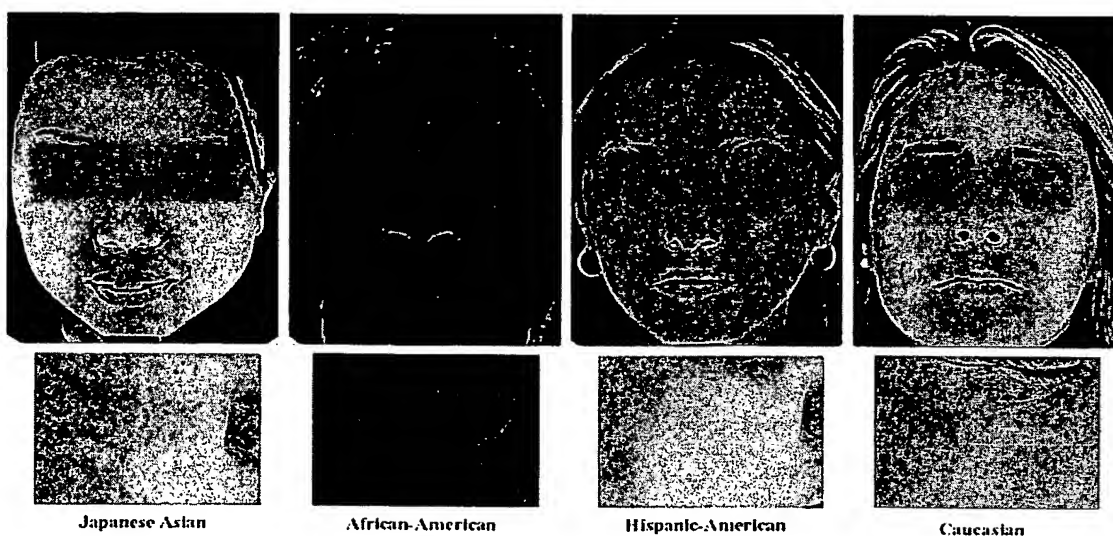


Figure 1 Face and cheek pictures of various ethnic groups.

Qualitative analysis: interviews

The 14 selected women from each group were involved in semi-directive in-depth interviews based on a specific guideline to establish self-perception about their skin complexion. The interviewer belonged to the same specific ethnic group in each case. The interviews were designed to explore the self-perception and description of skin complexion and skin tone of the volunteers and their expectations from liquid foundation.

Data processing

Data processing was carried out using the statistical analysis software SPSS 12. Makeup results were assessed by comparing skin color measurements before and after applying makeup product. As all variables used for statistics were found to follow normal distribution as shown by Kolmogorov test and variances were equal, the comparison was carried out using a paired Student's *t*-test.

Variance analysis was performed for comparisons between ethnic groups. This analysis was carried out with the ethnic group factor knowing the normality of residues. The limit for significance was $P < 0.05$.

Results

The results are presented according to the subject ethnic group. They include a quantitative and qualitative evaluation of skin color and self-perception, as well as insights into usage habits with respect to liquid foundation.

African-American women

African-Americans describe themselves as 'people of color.' They use a rather large palette of images. It includes expressions such as 'dark chocolate' and 'mahogany' to depict dark skin, and 'toast' or 'pecan' for lighter hues (Table I). They easily classified their skin with a lightness scale distinguishing dark, medium, and light complexion. The broad color range of African-American was reflected in the objective ChromaSphere measurements (Fig. 2). As expected, African-American women represented the darkest ethnic group tested. From lightness results, they could be clearly divided into the three sub-groups: dark, medium, and light skin color (Fig. 3) ($P < 0.05$ for L^*). The light and

medium sub-groups also could be significantly distinguished by their Chroma and hue mean values ($P < 0.05$ for C^* and h). They showed the greatest color dynamics between light and dark complexion (with a 9.9 cut in the lightness value; see Table I).

African-American women appeared to be concerned about color and texture unevenness of skin complexion. Subjects frequently complained about light/dark color variations. These remarks were confirmed by color differential measurements (ΔL^*) comparing cheek and chin values which showed most pronounced gaps in the group with lighter skin (ΔL^* value is 6.8, 5.4, and 4.9 in the light, medium, and dark sub-groups, respectively; see Table II). African-American women also expressed concern about visible texture irregularities: dark marks or scars and skin blemish, such as pimples, wrinkles, rough skin, large pores, and facial hair. These qualitative comments were substantiated by color data from *in vivo* measurements which reflected a high level of color unevenness (L^* evenness 2.9–3.2).

After applying foundation, all three African-American skin sub-groups were darker and redder (decrease in L^* and h values by -1.4 and -1.6 , respectively, for light skins, by -0.8 and -1.9 , respectively, for medium skins, by -0.8 and -1.9 , respectively, for dark skins, see Table III. These decreases are significant ($P < 0.05$) in the three sub-groups). The increase in 'red' tone was most significant in the African-American ethnic group (Fig. 4).

Hispanic-American women

Hispanic-American women divided themselves into three sub-groups, composed of light, medium and dark skin tones, which they described using terms such as 'tan,' 'olive,' or 'café con leche,' respectively (Table I). Women in all Hispanic-American sub-groups complained about the 'yellow tone' of their skin which had negative associations with conditions such as jaundice and other types of sickness. They used the word 'dullness' to depict their skin.

Nonetheless, quantitative measurements clearly characterized three color groups – light, medium and dark – with a wide range of hues (Fig. 3). The hue and Chroma parameters also significantly distinguished light and medium sub-groups ($P < 0.05$ for C^* and h ; see Table I). Unlike

Table I Color of bare skin in different ethnic groups: qualitative and quantitative assessment of skin color

	Sub-group	Light	Medium	Dark
African-American	Qualitative description	Toast, tannish, olive yellow, high yellow, pecan	Medium brown, medium dark, cocoa milk, brown	Dark chocolate, mahogany
	<i>L*</i>	52.3 ± 4.1	46.2 ± 5.3	42.4 ± 5.0
	<i>C*</i>	27.2 ± 1.3	24.7 ± 2.8	22.5 ± 3.8
	<i>h</i>	54.9 ± 2.2	52.3 ± 3.4	50.9 ± 4.8
Hispanic-American	Qualitative description	Café con leche, with a lot of leche	Café con leche, tan, olive	Tan
	<i>L*</i>	62.1 ± 3.0	60 ± 3.5	58.5 ± 3.9
	<i>C*</i>	25.3 ± 1.5	26.9 ± 1.6	26.3 ± 1.5
	<i>h</i>	49.5 ± 5.0	51.5 ± 3.5	53 ± 3.6
American-Caucasian	Qualitative description	Light almost white, beige, pinkish beige	Medium beige, medium ivory, grayish, yellowish	Dark, not white, tanned, bronze like, ripe peach, yellowish
	<i>L*</i>	62.8 ± 2.9	62.1 ± 2.3	60.2 ± 2.7
	<i>C*</i>	25.7 ± 1.9	26.6 ± 1.5	26.7 ± 1.3
	<i>h</i>	47.4 ± 5.2	48.8 ± 4.6	49.6 ± 4.0
French-Caucasian	Qualitative description	Light almost white, beige, pinkish beige, beige with redness	Medium beige, medium ivory, grayish, yellowish	Dark, not white, tanned, bronze like, ripe peach, yellowish
	<i>L*</i>	63.3 ± 2.7	61.5 ± 2.7	59 ± 3.2
	<i>C*</i>	26.4 ± 2	26.8 ± 1.8	28.4 ± 2
	<i>h</i>	47.3 ± 8.4	47 ± 6.0	49.5 ± 4.9
Japanese Asian	Tentative classification	Light	Medium	Dark
	<i>L*</i>	64.1 ± 2.7	62.5 ± 2.6	61.8 ± 2.9
	<i>C*</i>	25.0 ± 4.4	25.7 ± 1.4	25.9 ± 1.8
	<i>h</i>	53.1 ± 4.4	52.4 ± 4.1	53.1 ± 4.6
	Tone-based sub-group	Beige type	Standard color	Pink type
	Qualitative description	Yellow	Ocher	Pink, red on cheeks
	<i>L*</i>	61	62.6	64.8
	<i>h</i>	48.2	52.8	57.5

The words used by women in different ethnic groups to describe their own bare skin color. Each ethnic group is divided into three sub-groups (light, medium, or dark skin) according to women's self-perception. Tone-based sub-group classification as used by Japanese is also given for the related group. Qualitative description and the corresponding lightness and color values obtained from ChromaSphere measurements (mean ± SD) are shown for each sub-group. The values for lightness (*L**), chroma (*C**) and hue (*h*) of the cheeks were obtained by calculating the mean of a 300 × 300 pixel square area. Significance: *p* < 0.05 in bold, *p* < 0.1 in italics.

African-American women, the lighter the skin shade the redder the skin, whereas darker shades were associated with yellow skin tone ($\Delta h = +3.5$ between light and dark sub-groups).

Hispanic-American women commented on uneven color, notably beneath the eyes and red-dish marks. These complaints contrasted with data from measurement of skin tone which showed a fairly good evenness in all skin sub-groups (*L** evenness 2.3–2.4; see Table II).

Within each skin sub-group (light/medium/dark), we observed women who either lightened

or darkened or reddened their skin as a result of their own choice of foundation (see Fig. 5).

Caucasian women

The range of colors used to depict skin by the different color sub-groups in both Caucasian groups from the US and from France included terms such as 'beige,' 'medium beige,' and 'bronze-like' (Table I). American and French Caucasian women divided themselves into the three sub-groups (light/medium/dark). Color measurements

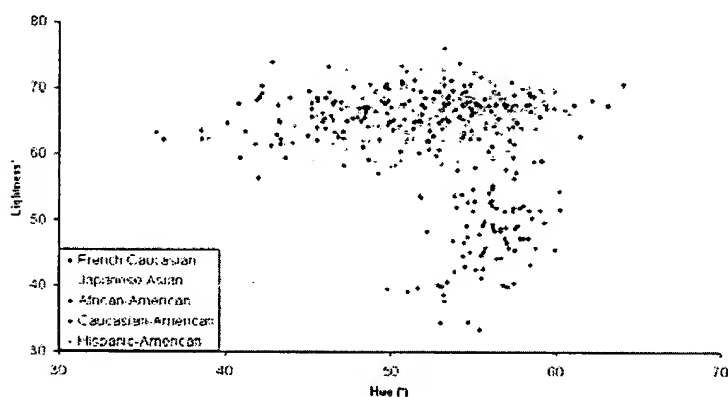
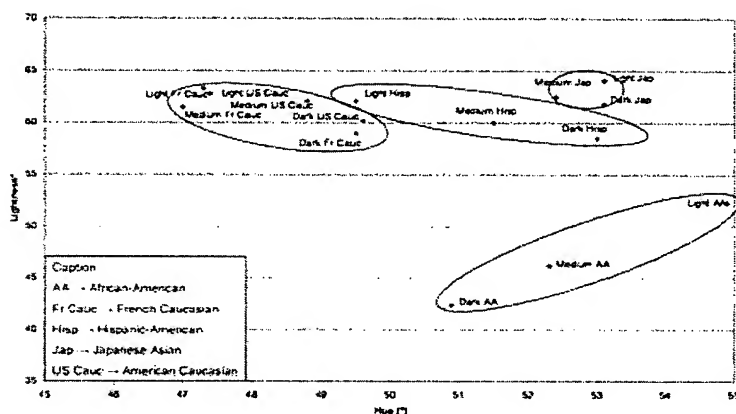


Figure 2 Continuous color space.

Figure 3 Cheek color space (h , L^*) of various ethnic groups according to skin complexion.

confirmed the relevance of these sub-groups in the French Caucasian women but only medium and dark skin sub-groups were distinguished significantly in US Caucasian women. Caucasian skins showed the highest values in 'red' tone and the lowest diversity in skin color (Fig. 2). We observed that the darker the complexion the more yellow the skin. Light skins in the US and in France were remarkably similar (L^* values are not significantly different; $L^* = 62.8$ and 63.3 in the light American and French sub-groups, respectively). Medium skins were 'redder' in France than in the US ($h = 48.8$ and 47.0 in the medium American and French sub-groups, respectively), and dark skins were darker in France than in the US ($L^* = 60.2$ and 59.0 in the dark American and French sub-group, respectively; see Fig. 3).

Skin defects most commonly mentioned included pimples, acne, blackheads, and wrinkles. They were often described as 'redness' by the

French subjects or 'dark blotches' by the US group. All in all, self-perception was found in good agreement with measurements of unevenness (L^* evenness 2.3–2.4 or 2.4–2.7, respectively; see Table II).

After makeup, complexions were significantly darker ($P < 0.05$) except in the light American skin group (no change in skin light and hue), and redder especially in the light French and in the medium American sub-groups (decrease in L^* and h values by -0.6 and -0.8 , respectively, for French light skins, by -0.5 and -1.0 , respectively, for US medium skins, $P < 0.05$; see Table III). The complexion is only slightly redder in the dark skin groups (decrease in h values by -0.5 in both Caucasian groups; see Fig. 4).

Japanese women

Although the other ethnic groups easily divided themselves into three sub-groups defined by color

Table II Unevenness of skin complexion: qualitative and quantitative assessment of skin color evenness in women from different ethnic groups

	Sub-group	Light	Medium	Dark	Mean value
Japanese Asian	Qualitative description	Mottled appearance (blemishes, dark circles under eyes), redness			2.7 ± 0.5
	Delta <i>L</i> *	2.4 ± 1.7	2.2 ± 2.0	3.2 ± 1.9	
	<i>L</i> *evenness	2.6 ± 0.5	2.6 ± 1.6	2.8 ± 0.4	
African-American	Qualitative description	Light/dark skin areas, dark marks, scars, freckles, dark under eyes circle			3.2 ± 0.5
	Delta <i>L</i> *	6.8 ± 2.9	5.4 ± 3	4.9 ± 3	
	<i>L</i> *evenness	2.9 ± 0.5	3.2 ± 0.6	3.2 ± 0.5	
Hispanic-American	Qualitative description	Dark beneath eyes, age brown spots, 'reddish marks'			2.4 ± 0.4
	Delta <i>L</i> *	2.5 ± 2.1	2.4 ± 2.8	5.3 ± 2.2	
	<i>L</i> *evenness	2.3 ± 0.4	2.4 ± 0.5	2.3 ± 0.3	
American-Caucasian	Qualitative description	Dark under eyes circles, light/dark areas, pigment spots (+older), freckles and moles			2.4 ± 0.4
	Delta <i>L</i> *	1.0 ± 2.1	2.0 ± 2.0	2.6 ± 1.9	
	<i>L</i> *evenness	2.3 ± 0.3	2.4 ± 0.4	2.4 ± 0.4	
French-Caucasian	Qualitative description	Redness, dark under eyes circles, light/dark areas, pigment spots (+older), 'mauvaise mine'			2.5 ± 0.4
	Delta <i>L</i> *	1.6 ± 2.3	1.8 ± 2.1	2.4 ± 3.1	
	<i>L</i> *evenness	2.4 ± 0.4	2.5 ± 0.4	2.7 ± 0.4	

Words used by women from each sub-group in the different ethnic groups to describe their facial skin irregularities (qualitative description) and data from skin color measurements: Delta *L** shows the difference between mean values of *L** recorded on cheek versus chin and *L**evenness is the standard deviation of lightness recorded on a representative 300 × 300 pixels cheek area. Significance: *p* < 0.05 in bold, *p* < 0.1 in italics.

Table III Measurement of skin color after makeup: quantitative assessment of skin color in women from different ethnic groups

	Sub-group (after makeup)	Light	Medium	Dark
Japanese-Asian	<i>L</i> *	64.7 ± 2.5	63 ± 2.4	62 ± 2.6
	<i>C</i> *	24.1 ± 1.6	24.8 ± 1.4	24.9 ± 1.7
	<i>h</i>	54.4 ± 3.4	52.9 ± 4.1	53.6 ± 3.7
	Delta <i>L</i> *	2.6 ± 1.3	2.2 ± 2.0	3.2 ± 1.7
African-American	<i>L</i> *	50.9 ± 4.1	45.4 ± 5.3	41.6 ± 4.5
	<i>C</i> *	27.4 ± 2.0	23.9 ± 3.0	22.1 ± 4.0
	<i>h</i>	53.3 ± 2.5	50.4 ± 3.6	49 ± 4.5
	Delta <i>L</i> *	5.7 ± 2.5	4.2 ± 2.5	4.0 ± 2.8
Hispanic-American	<i>L</i> *	61.8 ± 3.0	59.3 ± 3.4	57.4 ± 3.6
	<i>C</i> *	25.3 ± 1.6	26.6 ± 1.8	26.7 ± 2.4
	<i>h</i>	49.4 ± 3.9	50.3 ± 3.0	51.9 ± 2.9
	Delta <i>L</i> *	2.4 ± 1.9	2.0 ± 2.4	4.5 ± 1.6
American-Caucasian	<i>L</i> *	62.6 ± 2.7	61.6 ± 2.3	59.5 ± 2.9
	<i>C</i> *	25.5 ± 2.0	26.4 ± 1.7	26.5 ± 1.8
	<i>h</i>	47.4 ± 4.5	47.8 ± 4.7	49.1 ± 3.7
	Delta <i>L</i> *	0.8 ± 1.7	1.6 ± 1.6	2.3 ± 1.8
French-Caucasian	<i>L</i> *	62.7 ± 2.4	60.6 ± 2.6	58 ± 3.2
	<i>C</i> *	26.4 ± 1.9	27.2 ± 1.8	28.2 ± 2.0
	<i>h</i>	46.5 ± 7.2	46.5 ± 5.2	49 ± 3.7
	Delta <i>L</i> *	1.7 ± 1.9	1.8 ± 1.7	1.9 ± 2.3

Lightness (*L**), chroma (*C**), and hue (*h*) data recorded within a 300 × 300 cheek area in the different ethnic groups and sub-groups following the application of foundation products. Delta *L** values are based on comparative color measurements on cheek and chin of each volunteer. Significance: *p* < 0.05 in bold, *p* < 0.1 in italics.

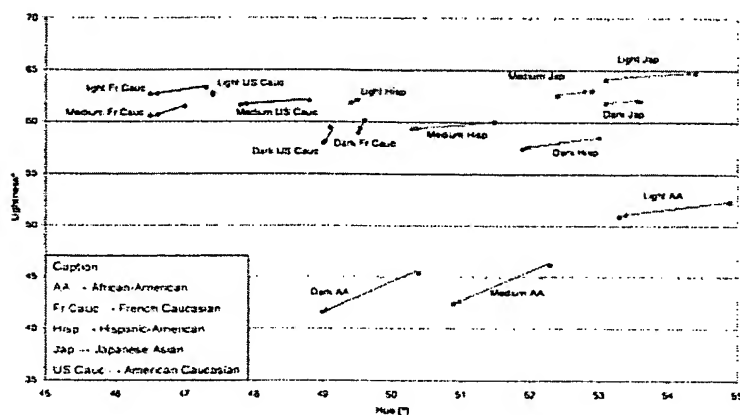


Figure 4 Effect of putting on one's makeup on hue (h) and lightness (L^*) of cheek.

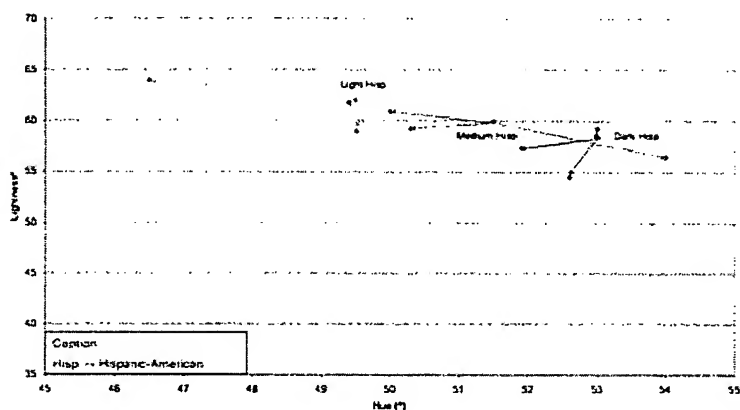


Figure 5 Before and after makeup: lack of consistency of results on hue (h) and lightness (L^*) in Hispanic-Americans.

intensity level, Japanese women described their complexion by skin tone (pink, ocher, and beige). In order to compare with the other ethnic groups, we asked Japanese women to choose between the three types of complexion (dark, medium, and light). Color measurements showed that this lightness scale had a limited interest: the three subgroups could not be significantly distinguished by their hue value ($h = 53.1, 52.4,$ and 53.1 for light, medium, and dark sub-groups, respectively; see Table I). Nevertheless the skin of Japanese women covered a wide range of hues, from 'beige' to 'pink' ($\Delta h = -9.5$ between Beige and Pink sub-groups; see Fig. 6 and Table I) which confirmed it made more sense to classify the skin according to a pink-ocher-beige color scale. Japanese women were the farthest in the 'yellow' tone among the ethnic groups (Fig. 3).

They seemed to be more concerned by unevenness of their skin color because of the presence of pigment spots. Data obtained from measurements

confirmed the high unevenness of skin color in Japanese group (2.6–2.8; see Table II).

Japanese women proved to be the only ethnic group with lighter and more yellow skin after applying foundation, especially in the light subgroup (increase in L^* and h values by $+0.6$ and $+1.3$, respectively, $P < 0.05$; see Fig. 4).

Discussion

Foundation plays a major role in makeup routine and is often used to hide perceived blemishes or defects in facial appearance. The history of foundation development, from theatrical makeup to routine cosmetic product, has obscured the differences across various ethnic groups as regards foundation needs and expectations. The evaluation of different skin complexion features and of their impact on foundation use is important for the development of novel cosmetic products that meet the needs of culturally distinct consumer markets.

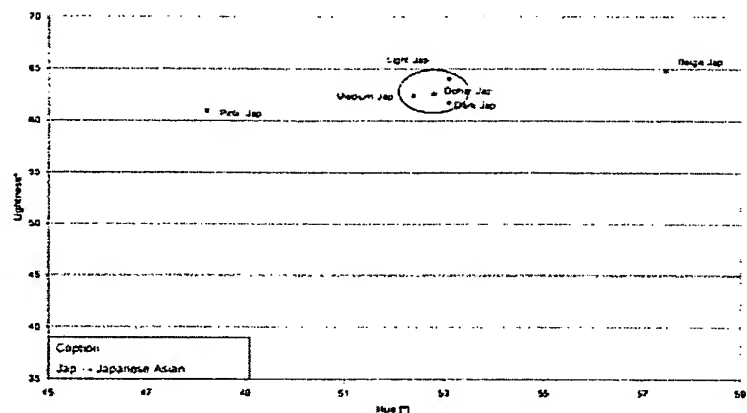


Figure 6 Japanese Asian specific feature: skin sub-groups defined by skin tone.

African-American women

Skin color is an important part of identity for this ethnic group. In general, dark skin complexions were well regarded by the African-American community. It reflected in the use of positive expressions to describe their skin tone. No women used negative words about color itself.

Although African-American women appeared to be fairly satisfied with their skin tone, they were yet concerned about unevenness. Provide evenness by covering up blemish was the major issue addressed when applying liquid foundation. Makeup application resulted in shades darker than the natural skin tone. In the group with dark facial skin, the women tended to choose shades at least as dark as their darkest skin area. Women with lighter skin color mostly chose a darker color, although a few individuals chose to lighten darker areas with a light foundation.

Thus, African-American women have a positive self-perception of their own color. Although they declared not to be satisfied with their usual foundation product because appropriate foundation shades are not available in store, they manage to improve their evenness by mixing several products. In general, after makeup session most women have a darker facial skin color and all sub-groups have much redder tones.

Hispanic-American women

Unlike the former group, Hispanic-Americans come from a wider range of geographical areas, which may differ in their specific cultural characteristics. The Hispanic group included women from

Puerto Rican, Dominican, Cuban, Venezuelan, or Mexican origin and many were recent immigrants. This diversity was reflected in a wide range of skin complexions in terms of the different hues between light and dark skins.

In contrast to the African-American group, we found that Hispanic-American women tend not to enhance their own skin color. There is however a certain overlap in the vocabulary used by women in the three Hispanic-American sub-groups (light, medium, and dark). The perception of skin color influenced makeup strategy. The approach to cosmetics is undoubtedly also influenced by the fact that the Hispanic-American group includes women having a wide range of cultural backgrounds which likely contribute to a certain discrepancy between skin makeup result and declared cosmetic approach. Even when subjects verbally described a consistent desire to seek darker skin tones with a view to achieve a 'sun kissed' skin color and to resolve perceived unevenness, the measurements of skin hues failed to support this strategy.

Overall the Hispanic-American group was characterized by divergence between self-perception of skin color and evenness compared with data from measurements before and after makeup. Thus, the negative self-perception of skin color by Hispanic-American women conflicted with quantitative data on skin tone features and with makeup strategies.

Caucasian women

Two independent groups of Caucasian women were involved in the study; one included women recruited in Paris, France, whereas the other one was made up of American women living in

New York. We observed a clear similarity between the results obtained from these two groups. This internal consistency emphasizes the importance of ethnic origin, rather than geographical factors or experimental bias introduced by different language used by different testing centers.

Unlike Hispanic women, the differences in skin tone description in the Caucasian groups were more related to intensity than undertone. Even so the complexion of Caucasian and Hispanic women showed similar features: the lighter the skin shade the redder the skin and the darker the shade the more yellow the skin. Dark Caucasian women and light Hispanic-American women defined a continuous color space with the same hue values.

As a general observation from in-depth interviews, we noted that Caucasian women were the least concerned groups about skin unevenness.

The general makeup strategy of the Caucasian groups tends to be focused on the use of foundation to generate slightly darker tones.

Japanese women

In this study, Asian skin was represented by Japanese women. It was of particular interest because of the cultural tradition of makeup in Japan, which is based on a process of layering 'thin films.' It is worth noting that Asiatic skin color is often described as 'yellow.'

In contrast to the Hispanic-American subjects, for whom 'yellow' skin had a negative connotation, the Japanese women did not describe their yellow skin color as a source of dissatisfaction.

Makeup strategies in this group consistently focused on improving the evenness of the skin, irrespective of age or skin tone sub-group. Interestingly, the Japanese women represented the only ethnic group which used foundation to make skin lighter and more yellow. They really unsaturated their skin color after makeup (Fig. 4). Despite the tendency of Japanese women towards clearer and unsaturated skin tone, they do not choose white foundation products.

Thus, in the 'color space,' the Japanese women occupy a space area that significantly overlaps with the Hispanic-Americans, yet their attitude towards 'yellow' skin is positive. Their makeup strategies are consistent with a desire to address the problem of skin color unevenness, which increases with age.

Conclusion

This paper reports a multicenter study that addresses the issue of makeup strategy of women in relation to skin color by combining both qualitative and quantitative approach. The main conclusions of the study are the followings. First, quantitative data obtained from methods used for measuring color and tone evenness are consistent with self-assessment of skin complexion by female volunteers involved in the study and particularly Caucasian, Japanese, and African-American women.

Second, in a given ethnic group except Hispanic-American, most of the women have the same and clear makeup strategy, i.e. aiming at a skin color darker and redder for Caucasians and African Americans, lighter and more yellow for Japanese. Hispanic-Americans show more variable in makeup choice. Results of measurements also demonstrate a surprising diversity of skin color covering a large, continuous space with overlapping of the different ethnic groups. Reliable skin color evaluation is instrumental in designing products most likely to meet with the needs of women from different ethnic backgrounds living in different countries and having various skin color features and concern.

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